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HYDROCYANIC ACID GAS AS A FUMIGANT

FOR DESTROYING HOUSEHOLD INSECTS

1932

FUMIGATION with hydrocyanic acid gas is one of the most effective methods of destroying household insects. It is equally suitable for use in ordinary dwellings, in apartment houses, and institutional buildings such as hospitals, and in loosely constructed temporary or portable structures. This gas is, however, extremely poisonous to human beings, and should not be used without knowledge of the dangers involved and of the precautions to be taken.

There are several methods of generating and applying hydrocyanic acid gas in fumigation. The pot method, which consists of placing sodium cyanide in a mixture of sulphuric acid and water in an earthenware crock or a barrel, is the safest method for the inexperienced householder who wishes to fumigate a few rooms or a small house. The other methods involve exposure of various forms of calcium cyanide or liquid hydrocyanic acid, either pure or combined with some absorbent material, and should be used only by an experienced fumigator.

The details of these methods and the precautions to be taken are described in this bulletin. By carefully following these instructions any intelligent person can safely use hydrocyanic acid gas and obtain excellent results.

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HYDROCYANIC ACID GAS AS A FUMIGANT FOR DESTROYING HOUSEHOLD INSECTS

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WHY HYDROCYANIC ACID GAS IS A GOOD FUMIGANT

HYDROCYANIC ACID GAS is one of the most effective, useful, and popular fumigants known for destroying insects in structures occupied by man. When breathed in concentrated form it is deadly to human beings as well as to insects, but with proper precautions can safely be used in fumigating not only ordinary homes, but apartment houses (fig. 1), detached hospital and institutional buildings (fig. 19), and portable structures such as convicts' bunk wagons (fig. 2), automobile trailers, and Pullman cars. It is frequently used to destroy clothes moths and carpet beetles in the finest dwellings. (Fig. 5.)

Hydrocyanic acid gas combines good features possessed by no other fumigant. It can be used without fear of fire or explosion, without dismantling or disarranging the house furnishings, and with harmful effects upon few of them. Its cost is small; it can be removed from the buildings in a very short time; and it kills so quickly that it can be used in houses so poorly constructed that other fumigants escape before they have had time to become effective. (Fig. 3.) Being lighter than air, hydrocyanic acid gas escapes upward when windows and doors are opened, or through cracks in buildings, and does not settle to form a dangerous blanket of vapor upon sidewalks or roadways. Modern buildings of concrete and brick are extremely tight and such gas as escapes does so slowly and is dissipated upward and away from completely detached buildings.

FIGURE 1.—Apartment house fumigated with hydrocyanic acid gas. Very few windows on sides. The frame buildings on either side of the apartment building, and separated from it by narrow alleys, were occupied during the entire period that the apartment house was being fumigated. A professional fumigator was on the ground all the time to make note of conditions

FIGURE 2.—A prison bunk wagon such as is used for convict labor. Vermin in the beds of such structures can easily be killed by covering the entire conveyance with tarpaulins and fumigating with hydrocyanic acid gas

DANGER IN THE USE OF HYDROCYANIC ACID GAS

Hydrocyanic acid gas is deadly to all animal life, including human beings. It should be used only by persons who have thoroughly acquainted themselves with the method of using it and with the dangers involved. It is preferable for fumigations to be conducted by professional fumigators, but it is quite possible for a careful, well-informed person to use hydrocyanic acid gas with safety and with excellent results, particularly in fumigating only one or a few rooms. In the thousands of house fumigations which have been made, only a few deaths have occurred, and these have been the result of ignorance or of extreme negligence on the part of the persons conducting the fumigations, who failed to make certain that all persons were out of the buildings before generating the gas or to guard against the entry of those unaware that fumigation was in progress.

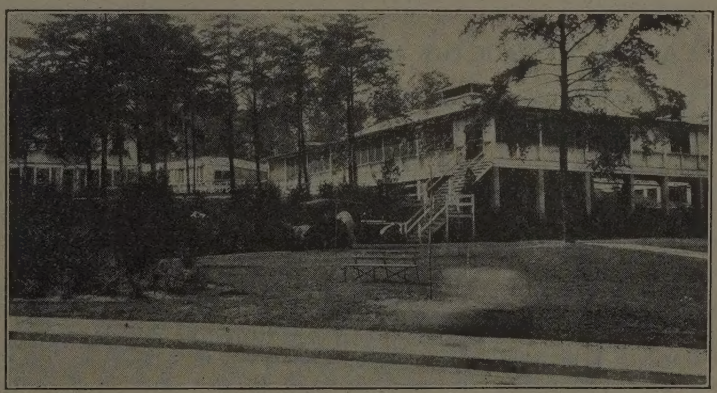

FIGURE 3.—A temporary mess hall and kitchen at a hospital were fumigated with hydrocyanic acid gas for four hours to control cockroaches. (For diagram of floor plan see fig. 9.) Persons passed at ordinary pace along the corridors surrounding this building without the least ill effect from escaping gas. There should, of course, be no loitering about the walls of buildings that are being fumigated

Hydrocyanic acid gas can cause death in a few minutes if it is breathed in concentrated form. From 5 to 10 breaths of the gas in the concentration used in house fumigation are sufficient to kill the average person. According to R. Kobert, a concentration of 120 to 150 parts of the gas per million parts of air is dangerous in from 30 to 60 minutes, while one of 3,000 parts per million is quickly fatal. In weak concentrations the gas is not acutely dangerous, but may cause dizziness, vomiting, or even loss of consciousness. When inhaled in concentrated form, it prevents oxidation in the tissues, so that, although breathing continues for a brief period, the oxygen can not be utilized and death from asphyxia soon results.

SAFEGUARDS IN THE USE OF HYDROCYANIC ACID GAS

Hydrocyanic acid gas must be handled with great care, not only for the safety of the operator, but for the safety of the general public. In most cities its use is regulated by the public health department, which forbids its use without a permit.

Before a building is fumigated, all persons except the operator must leave the premises and remain away until the work has been completed and the building properly ventilated. If one of several apartments in a building is to be treated, arrangements must be made for occupants of all apartments to vacate during the fumigation period. In most cities it is unlawful to fumigate a semidetached or "row" house unless the occupants of the adjoining house on each side also vacate. A building being fumigated should have all entrances locked and signs prominently displayed to warn persons approaching the building that it is being fumigated with a deadly gas. In addition, one or more guards should be stationed to keep persons from loitering on sidewalks and from attempting to enter the building.

Guards, grossly neglecting their duties for even a few minutes, have been responsible for fatal attempts to enter buildings under fumigation.

VACATING ADJOINING APARTMENTS AND BUILDINGS

The common insect pests of dwellings spread so easily from one apartment to another in an apartment house, that cooperation in vacating all apartments for several hours during the daytime to permit intelligent fumigation of one or more apartments, if not the entire building, would be to the tremendous advantage and peace of mind of all occupants. Whatever is done to kill insects in one apartment is to the advantage, and for the protection, of all others in the same building.

It is often feasible to fumigate a well-constructed "row" house while the adjoining houses are still occupied, but this should never be attempted unless the occupants of the adjoining houses agree in advance to keep their houses open for frequent inspection by the professional fumigator and to be in readiness to vacate on a minute's notice should the gas be found to be leaking through the party walls. Special care should be taken to see that there are no cracks in party walls and no underground or basement connections of any sort along which the gas can escape from the house under fumigation. Sometimes, when the leakage of gas is great on account of loose construction, a breeze may blow enough of the diluted gas to near-by structures to make them dangerous. If this occurs, the fumigator should insist on shutting all windows facing the building under fumigation.

PREPARING A ROOM FOR FUMIGATION

In preparing a room for fumigation, all openings such as windows, fireplaces, hot-air registers, ventilators, and stovepipes should be closed and made as tight as possible with the aid of gummed or pasted strips of paper or by crowding wet newspapers or rags into cracks and crevices. Larger openings, such as fireplace flues, can conveniently be closed by crowding into them pillows previously wrapped with old papers or cloth. Windows should be wedged as tightly as possible even when sealed with paper. Closets, bureau

drawers (fig. 4), trunks, boxes, and other containers should be opened to facilitate the penetration of the gas. The contents of tightly packed trunks may be hung on a line temporarily installed in the room. It is wise to drape blankets and other bedding over bedsteads, chairs, or open closet doors, and to raise mattresses a little from the springs. Carpets and rugs may be raised off the floor in places by resting them on chairs. Many living and dining rooms are fumigated with apparent success, however, without moving carpets except by turning them back about the edges wherever furniture will permit.

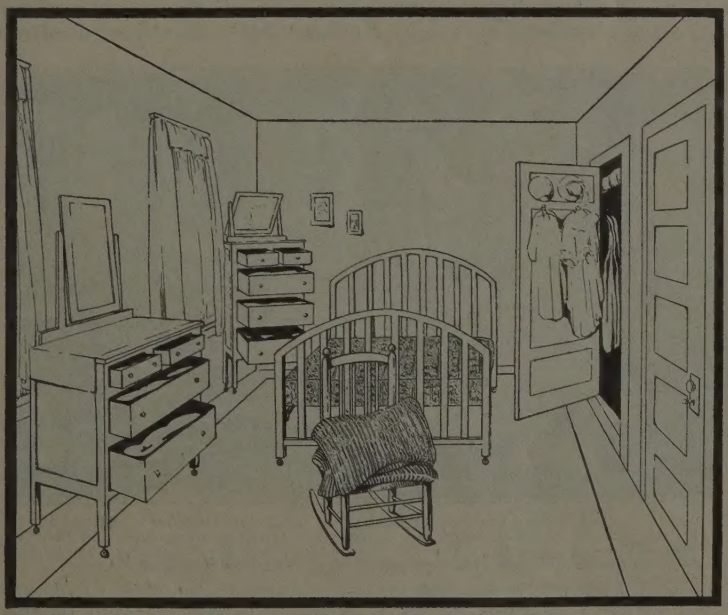

FIGURE 4.—Sketch of bedroom showing bureau and dresser drawers and closet door opened as they should be during a fumigation

Living plants, liquids, and moist foods should be removed before fumigation, and it is better to remove fine watches and small clocks, although larger clocks can remain. Fabrics, including tapestries and paintings, silverware, copper, brass, and gilt frames are not known to be affected. (Fig. 5.)

Unless the fumigator is equipped with a gas mask, it is best to arrange to ventilate the room or house by opening windows and doors from the outside. Usually the opening of the front and back doors on the ground floor and several windows on the ground and second floors of dwellings will result in a rapid ventilation. The ventilation of larger buildings requires special preparation in advance, if gas masks are not used.

METHODS OF GENERATING HYDROCYANIC ACID GAS

There are several methods of generating hydrocyanic acid gas, all of which are effective and available for household fumigation. Some can be used with safety by any intelligent person, even if inexperienced, while others should be used only by the experienced fumigator. The simplest and safest method for the householder wishing to fumigate a few rooms, or an entire small house, is the so-called "pot method," which consists of placing sodium cyanide in a mixture of sulphuric acid and water in a potlike container or generator. The other methods consist of exposing various forms of calcium cyanide or liquid hydrocyanic acid, either pure or combined with some absorbent material. Such methods should be used only

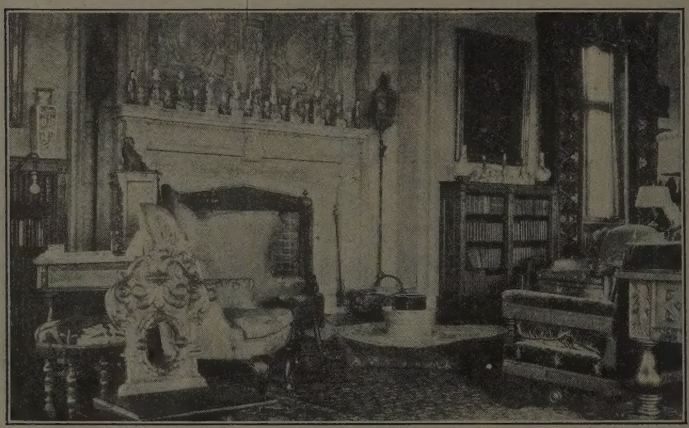

FIGURE 5.—Room in fine home under fumigation for the destruction of clothes moths and carpet beetles. Paintings, gilt frames, rare tapestries, fine rugs, and furnishings need not be removed. Note the crock placed near the fireplace. The rug has been laid back and plenty of newspapers have been used about the crock

by an expert fumigator, or by a person who has received personal instruction through demonstrations given by a professional. Simple as the procedure usually is, the operator must always proceed with great caution.

THE POT METHOD

CHEMICALS REQUIRED

The pot method of generating hydrocyanic acid gas is so called because the chemicals used in the process are placed together in a pot or vessel of similar form. (Figs. 6 and 7.) The chemicals required are a good grade of sodium cyanide (96 to 98 per cent), a commercial grade of sulphuric acid (66° Baumé), and water.

Sodium cyanide, which has displaced potassium cyanide in present-day fumigations, is a white, crystalline substance that for fumigation purposes is prepared in egg-shaped lumps weighing approximately 1 ounce each. Sodium cyanide is a violent stomach poison and in addition may be absorbed through open cuts on the

hands. It is best to handle it with gloved hands and to keep unused portions in glass containers to prevent spoilage. Small particles eaten by children or pets are sure to cause death. Sodium cyanide can be purchased in tin cans containing from 1 to 100 pounds or more. In 1-pound tins it sells for about 40 cents per pound; in 100-pound lots for 16 to 22 cents per pound. It is well to calculate the quantity needed, purchase a tin or tins containing an amount nearest that required, and use all of it, thus avoiding the necessity of caring for or disposing of left-over stock.

Pure sulphuric acid is a heavy, colorless liquid, but the commercial acid used in large-scale fumigation work is apt to be slightly discolored, or murky, owing to impurities. It is highly corrosive, and will cause injury if it spatters on the clothing or the body of the operator, or upon floors or rugs. It can be purchased in glass bottles

FIGURE 6.—Crocks used in fumigating a large modern dwelling by the pot method. Note the carboys of sulphuric acid, keg of sal soda, and the cans of sodium cyanide near the porch. All water and acid were added to the crocks outside the house and all cyanide was weighed and wrapped in the open air by gloved assistants

for about 10 cents per pound (about one-half pint) or in carboys for about 4 cents per pound. For small-scale fumigations 8-pound bottles of acid are convenient.

FORMULA

To obtain the best results the chemicals should be mixed according to the following formula:

Sodium cyanide (96 to 98 per cent), ounce by weight	1
Sulphuric acid (66° Baumé), fluid ounces	1½
Water, fluid ounces	3

Since there are 16 ounces in 1 pound and 32 fluid ounces in 1 quart, this formula requires 1½ pints of sulphuric acid and 1½ quarts of water for each pound of sodium cyanide. This is known as the 1–1½–3 formula and is more generally satisfactory than the 1–1½–2 formula, which may produce a little more gas but makes it more difficult to empty the jars after fumigation, because of the larger number of crystals in the residue.

PROPER ORDER OF PLACING CHEMICALS IN THE FUMIGATING JAR

To generate hydrocyanic acid gas by the pot method, the operator should first pour the water into the generator or crock and then add the acid. If the water is poured into the acid, the reaction is so violent that the operator may be dangerously burned by the spattering of the acid-water mixture. The addition of the sodium cyanide to the mixture of water and acid causes an immediate chemical reaction and hydrocyanic acid gas is given off. The fumigant, mixed with some steam produced by the violent chemical reaction, has the appearance of ordinary steam or light bluish smoke (fig. 7) and an odor resembling that of peach kernels. The pure gas is colorless.

FIGURE 7.—The charge of cyanide has been lowered into the jar, and hydrocyanic acid gas and steam are rising in the first rapid evolution of the gas, which occurs as soon as the acid eats through the paper covering the cyanide. This type of jar is not recommended; the type shown in Figure 6 is preferable

DOSAGE

The dosage is computed on the basis of the amount of sodium cyanide required. For general fumigation work in a reasonably well constructed house 1 pound of sodium cyanide will produce enough gas to treat 1,000 cubic feet of space. If the house is loosely constructed or a very short exposure is given, from 1½ to 2 pounds of sodium cyanide may be needed.

HOW TO FIGURE THE QUANTITIES OF CHEMICALS NEEDED

In figuring the quantities of chemicals needed to fumigate a room at the rate of 1 pound of sodium cyanide per 1,000 cubic feet, the room should be measured and the cubic contents obtained by multiplying the length by the breadth by the height. For example, a room 10 feet wide, 20 feet long, and 10 feet high contains 2,000 cubic feet and requires 2 pounds of sodium cyanide, 3 pints of sulphuric acid, and 3 quarts of water.

TYPE OF GENERATOR

The best type of container or generator in which to mix the chemicals depends largely upon the size of the inclosure to be fumigated. If rooms of from 2,000 to 3,000 cubic feet are to be treated, a 4-gallon earthenware or stone crock will be suitable. For smaller rooms 2-gallon or 3-gallon crocks or even enameled wash basins will serve. If wash basins are used, the enamel should be clean and unscratched; otherwise the acid may eat through the metal and injure the floor.

For large houses a few large containers (figs. 8, 9, and 10) are sometimes preferable to many small ones. (Figs. 6 and 11.) In such cases 50-gallon wooden barrels can be used. They are large enough to handle safely a charge of 30 pounds of sodium cyanide, or sufficient material to fumigate 30,000 to 40,000 cubic feet of space. (Fig. 8.) Such barrels must be water-tight. They should be thoroughly scrubbed, both within and without, filled with water, and allowed to stand for at least 12 hours previous to their use. Ordinary oil or molasses barrels are usually satisfactory if all hoops are sound. Flour barrels are not heavy enough.

Before the chemicals are added, the barrels should be set in galvanized-iron washtubs (fig. 12) in each of which has previously been

FIGURE 8.—A large dormitory room containing about 40,000 cubic feet of space in a tight brick building. A dosage of 32 pounds of sodium cyanide in the 50-gallon barrel shown satisfactorily stamped out a bedbug infestation. The barrel should have been placed in a galvanized-iron washtub. The old cloths used about the barrel would not have protected the floor had the barrel leaked. Note opened trunks

placed a pailful of water containing several handfuls of ordinary washing soda. This is a precaution against leaking of barrels and provides for catching and neutralizing any small quantities of the acid-water mixture that may work out of the barrel. Galvanized-iron tubs containing a similar soda solution should also be used, if possible, when crocks are used as generators.

HOW TO GENERATE THE GAS

After the room or house to be fumigated has been prepared according to the directions on page 4, the generators should be distributed and the water and acid added. The acid should be added to the water slowly, since this operation produces heat, and a too-sudden change in temperature is likely to cause the crocks to crack. If the floors are highly polished and will be damaged by the heat

from the jars, the jars may be set on bricks set in each tub. If crocks are used, the water and acid should be added outdoors (fig. 6) or in a room with a concrete or tile floor, and with drain close by so that the breaking of a crock will not result in an acid-burned floor.

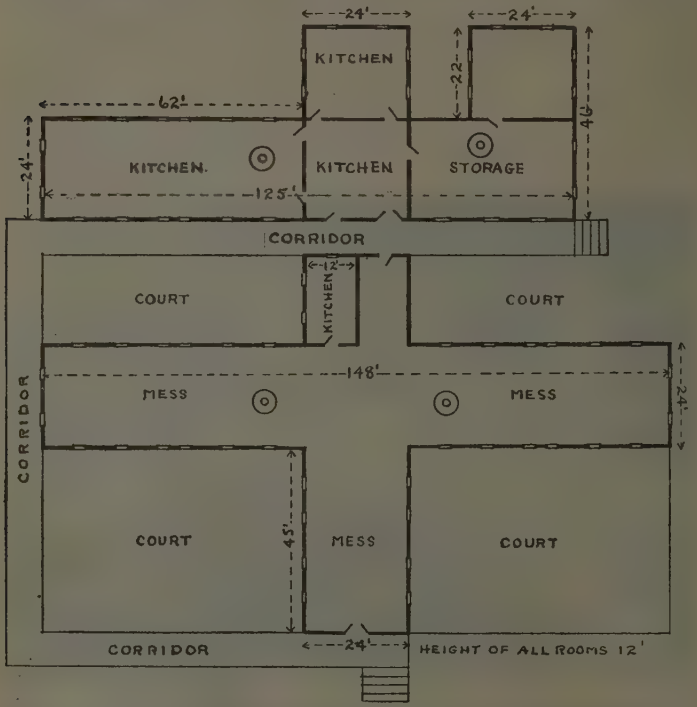

FIGURE 9.—Floor plan of mess hall and kitchen and storage of building (shown in fig. 3). The construction is temporary and very loose. Fumigation with hydrocyanic acid gas for 4 hours put an end to a serious cockroach problem without endangering occupants in near-by buildings. Barrels were used according to the pot method. The fires were left burning in the kitchen

FIGURE 10.—Floor plan of nurses' quarters fumigated with hydrocyanic acid gas for bedbugs by placing two barrels in center of hall. Wind during the period of fumigation prevented concentrations on windward side sufficient to kill the insects. Results would have been better had crocks been placed in each room and the room doors kept shut

It is even more advisable to fill barrels outside if labor is plentiful and the charge for carrying them in is not too heavy.

The proper quantity of sodium cyanide, which should be weighed out beforehand, should be placed in a paper sack or small piece of newspaper, in a compact bundle, and set near the generator to which

it belongs. If several generators are employed, the generation of the gas can be delayed by wrapping the cyanide in several thicknesses of paper or by using two paper bags of different size and

FIGURE 11.—A dining room with table and rugs placed to one side. Eight 4-gallon crocks are shown with acid and water in them. The sacks of cyanide have not been placed beside the containers, as this is one of the last steps before the gas is generated. Note the arrangement of newspapers to catch any chance spattering of acid during the evolution of the gas

placing the smaller inside the larger. The gas will not generate until the acid has eaten through the paper, so the operator will have a longer time in which to complete his work and escape than if only one thickness of paper were used.

When all is ready, the fumigator should start upstairs in the room farthest from the stairway, gently lower the bag of cyanide into the generator containing the acid and water, leave the room, and close the door. He should repeat the operation in the other rooms on that floor, proceed to the downstairs rooms and start the generators there, then leave by a predetermined exit. If all the rooms on the first and second floors are fumigated as a single unit (fig. 13) by using one or two large containers on the first floor, all the inside doors are left open and the containers are located close by the exit door.

FIGURE 12.—A 30-gallon barrel in a galvanized-iron washtub. To carry such equipment into and out of buildings requires two strong men unless the chemicals are added and emptied by pails. These men are about to empty into a city drain the residue following a hydrocyanic acid gas fumigation

In buildings equipped with fire-alarm systems which are set off by heat, the generation of hydrocyanic acid from large charges of cyanide in barrels directly beneath the wires may cause the alarm to ring. This can be avoided by properly placing the barrels.

If the cyanide is well wrapped, one person will have sufficient time to start the generators in all the rooms in an ordinary house before there is danger of being overcome by the gas. In larger houses two or more persons can work together. A definite plan should be made and rehearsed in advance, so that each man knows just what he has to do and when he is to do it. The work should be done rapidly, but not recklessly or nervously. If a charge is overlooked, let it go; to go back is dangerous.

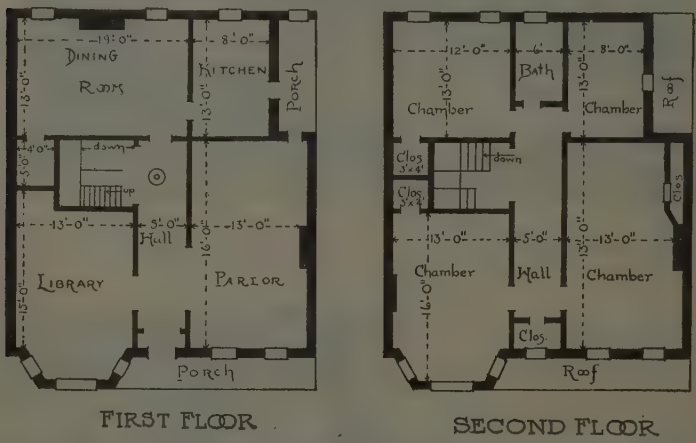

FIGURE 13.—Floor plan of first and second stories of a dwelling fumigated by the pot method. One oil barrel was used for the entire house and was placed in the hallway on the first floor. Insects placed in rooms on the first and second floors as a test were killed, indicating good results when but one container is used. It is generally believed that better results follow the fumigation of each room as a separate unit, and this is undoubtedly true in some instances. The 1-container method is cheap and easy

PRECAUTIONS AGAINST SPATTERING FLOORS, RUGS, AND OTHER FURNISHINGS

The fumigator should guard against the possibility of the acid-water mixture spattering out of the container during the rapid evolution of the gas after the cyanide has been added. Too large a dosage of cyanide for the container will cause this spattering. He should never put a 3-pound charge of cyanide into a 3-gallon crock, but use a 4-gallon crock instead. For a 2-pound charge he should use a 3-gallon, or larger, crock. Newspapers or other papers should be spread on the floor beneath and around the container (fig. 11) and, while the containers should be at least 4 feet from furniture, if it is necessary to place them closer, the sides of the furniture should be well covered with newspapers.

LENGTH OF EXPOSURE

The duration of the exposure may be varied to suit the requirements. An 8 to 12 hour fumigation is desirable because it gives the gas an opportunity to penetrate thoroughly. In general, the longer the fumigation period the smaller the dose required, although in a loosely constructed house, such as the ordinary American frame dwelling, a killing concentration can not be maintained for any great length of time.

When necessary, the period of fumigation can be reduced to as little as 4 hours, and with an increased dosage a 2-hour fumigation has given satisfactory results in killing bedbug and flea infestations. Short exposures are necessary in rooming and boarding houses that can not be vacated for very long periods.

EMPTYING CONTAINERS

After fumigation by the pot method, and the thorough ventilation of the building as described on page 17, the residue must be emptied from the containers. Sometimes a part of it becomes crystallized, or "frozen," and must be broken up with a stick. Sometimes the chemical reaction is imperfect because not all the cyanide comes into contact with the acid. For this reason the operator should proceed with caution until he is assured, by its failure to bubble, that the residue is safe to handle. This residue is somewhat acid. In handling the containers one should breathe as little as possible and keep the head turned aside.

The residue can be dumped down street drains or even flushed quickly down house toilets. It is better, however, to dig a hole in the ground and pour the residue into it; after the residue has sunk into the earth the hole should be filled.

THE CALCIUM CYANIDE METHOD

Calcium cyanide in dust form can be used successfully for household fumigation. The dust is extremely sensitive to moisture, and when it is exposed to air a chemical reaction between the calcium cyanide and the atmospheric moisture takes place and results in the liberation of hydrocyanic acid gas. The gas is given off so rapidly that the material is dangerous to use unless the operator is equipped with a gas mask. It should be used only by a professional fumigator.

Inasmuch as calcium cyanide dust is applied merely by spreading it thinly on a strip of paper on the floor, its use is more convenient than the pot method because it eliminates the disagreeable task of measuring and weighing the chemicals, the danger of spilling the acid and of cracking the jars, and the necessity of emptying containers after the gas has been generated.

METHOD OF APPLICATION

After a room has been tightly sealed in preparation for fumigation, strips of paper or newspaper should be laid across the floor. The fumigator, wearing a mask, should then distribute the necessary

number of cans of the fumigant, loosen the caps, quickly scatter the contents over the paper strips in as thin a layer as possible (fig. 14), and leave the room.

The operator should always begin distributing the powder at the point farthest from the door, so that he will be working away from the gas that is being given off from the exposed material. After the fumigation the paper on which the calcium cyanide has been spread can be rolled up and thrown away. A small percentage of the available hydrocyanic acid gas may be retained in the dust after the fumigation; hence, it is advisable to dispose of the residue outside the building. After all the hydrocyanic acid gas has been given off, the residue is nonpoisonous.

FIGURE 14.—Calcium cyanide dust laid on a paper runner the length of a room. Note that the room has not been disarranged in the least. Hydrocyanic acid gas begins to be evolved as soon as the material is exposed to the moisture in the air. When rooms are opened for ventilation, a strong breeze may blow the residue about the room

QUANTITY REQUIRED

The quantity required will depend upon the percentage of available hydrocyanic acid gas in the fumigant. If, for example, it contains from 50 to 55 per cent available hydrocyanic acid gas, a dosage of 1 pound per 1,000 cubic feet of space is needed for satisfactory fumigation, with an exposure of from 8 to 24 hours.

The material can be purchased in cans of various sizes, adapted for sprinkling the fumigant on the floor. Labels on the cans give the strength of the contents and directions for dosage and application. Calcium cyanide sells for $1.35 per pound.

THE USE OF LIQUID HYDROCYANIC ACID

Liquid hydrocyanic acid is a volatile, colorless liquid boiling at a temperature of 79.9° F. On exposure to air it gives off the same gas that is generated by the pot or other methods. It is too dangerous to be handled by the average householder and should be applied only by an expert. In the fumigation of houses the gas is distributed by

means of a system of ¼-inch piping or by the use of rubber hose. The liquid, which is marketed in cylinders containing 30 or 75 pounds, is forced into the piping system from the outside of the house by means of compressed air. (Fig. 15.) It is broken up into a fine spray by means of spray nozzles and vaporizes immediately. A dosage of 5 to 8 ounces of the liquid per 1,000 cubic feet of space gives satisfactory results.

The cost of liquid hydrocyanic gas ranges from $1.25 per pound for single 75-pound cylinders to 80 cents per pound for quantities in excess of 10,000 pounds.

FIGURE 15.—A cylinder of liquid hydrocyanic acid attached to a pipe line through which the liquid can be pumped into the building

THE USE OF HYDROCYANIC ACID ABSORBED IN INERT MATERIAL

Hydrocyanic acid absorbed in diatomaceous earth or other inert material is available as a household fumigant in the form of a coarse, brown, slightly damp, loose granular material (fig. 16) or in the form of compressed waferlike disks. (Fig. 17.) In either form it should be used only by professional fumigators. It comes in tin cans and upon exposure to air gives off the hydrocyanic acid gas so quickly that gas masks are necessary. It may be purchased either with or without small quantities (about 5 per cent) of chloropicrin, which produces a lachrymatory effect and warns any persons exposed to the gas.

GRANULAR MATERIAL

The granular material consists of nearly equal parts by weight of liquid hydrocyanic acid and diatomite. It is packed in hermetically sealed cans and is sold on the basis of the net content of hydrocyanic acid—20 grams, 100 grams, 500 grams, 1,000 grams, etc. It costs from $1.00 to $1.20 per pound of hydrocyanic acid, depending upon the amount purchased. If a warning gas is included an additional 10 cents per pound is added. It runs freely from an opening about 1½ inches in diameter and is convenient for fumigating single rooms or houses, since the cans are not bulky and are easily transported. No extra equipment, such as crocks, cylinders, or piping, is

needed, and the cans, and the residue, which is nonpoisonous, can be thrown away as harmless after the fumigation.

After the room or structure to be fumigated has been sealed, strips of paper on which to spread the fumigant are placed on the

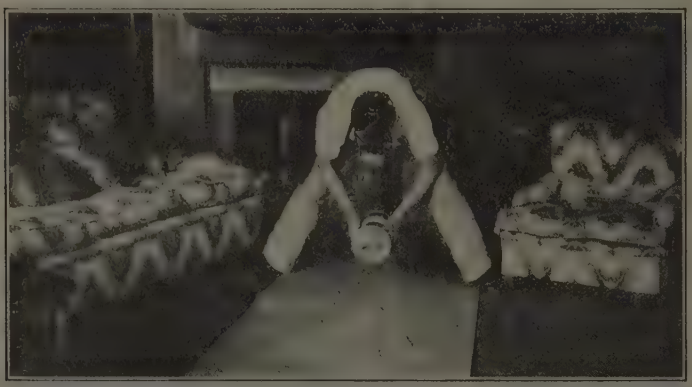

FIGURE 16.—A granular diatomaceous earth impregnated with hydrocyanic acid. Note that the man, wearing a gas mask, is pouring the material out of the can, in which it comes, onto a roll of paper spread directly upon the rug. During fumigation all the hydrocyanic acid gas is evolved from the material. After ventilation the residue can be rolled up in the paper and thrown into the trash without danger of poisoning man or animals

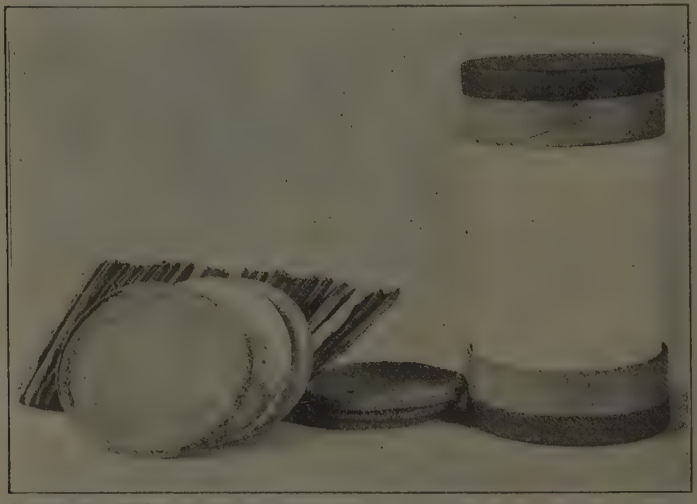

FIGURE 17.—Waferlike disks of diatomaceous earth impregnated with liquid hydrocyanic acid. They are marketed in cans, one of which is shown to the right

floors and the necessary number of cans are then distributed. Since the gas is given off with great rapidity when the material is exposed to the air, a gas mask must be worn during the entire fumigation. A small hole is punched in each can to relieve the pressure of free

gas that has accumulated. In making this initial opening it is well to tip the can away from oneself in order not to be sprayed with the first outrush of gas. A larger hole is then made and the contents of the can are at once poured onto the paper in a layer not more than one-half inch in thickness. (Fig. 16.) A special hammer having a tempered cutting head which cuts a 1½-inch opening in the top of the can with one stroke is manufactured.

The fumigator should always work from upper to lower floors and should first empty the can farthest from the point of exit and gradually work his way toward the door. For the sake of safety, at least two men should always work together, and enough men should be available so that one man need not empty more than 30 cans. When more than 100 cans are required, they should be opened outside the house by completely removing the tops of the cans and replacing them with rubber caps. This procedure saves time and simplifies the work of application.

After the fumigation the building can be ventilated and the empty cans and residue discarded.

WAFERLIKE DISKS

Hydrocyanic acid is sometimes sold absorbed in a bibulous material pressed into waferlike disks (fig. 17) resembling circles of heavy cardboard. These disks must be used only by an experienced fumigator while wearing a gas mask. They are used in the same manner as the hydrocyanic acid absorbed in the coarser material just discussed, but the disks are much cleaner and make fumigation and cleaning up easier. The disks, each of which contains approximately one-half ounce of liquid hydrocyanic acid, should be distributed on several layers of paper; otherwise the liquid they contain is likely to injure the finish of the floors. The disks are also sold on the basis of net content of hydrocyanic acid, the cost being the same as for the granular material.

VENTILATING A HOUSE AFTER FUMIGATION

At the end of the fumigation period the house must be ventilated before it can be occupied. If the operator has a gas mask, he can enter the building and proceed to open all windows and doors.

Large buildings, such as those shown in Figures 1, 18, 19, and 20, should be fumigated and ventilated only by professional fumigators equipped with gas masks. In a small building, such as an 8-room 2-story house, the ventilating can be done from outside the house without the use of a gas mask. If the various rooms have been fumigated as separate units by closing their doors into hallways, a window in each room must be opened from outside. Perhaps the easiest method of opening windows in the upper stories is to attach a cord or wire to the lower part of the upper sash. A strong pull will open the window. Windows and doors on the first and basement floors can be opened from without.

If the rooms of the house have been fumigated as a single unit from a center hall, opening a first-floor door and one or more second-story windows will effect a good ventilation. If it is difficult to open upper windows, the lower floor and basement may be ventilated

first and then upper rooms may be opened one at a time until no strong odor of the fumigant remains.

If the atmosphere is light and airy and a breeze is blowing, a house can be ventilated within 30 minutes so that it is safe to enter and

FIGURE 18. A frame structure used for school purposes in a large northwestern city. Although set directly on the street, and close to other buildings, it was fumigated with hydrocyanic gas for the destruction of bedbugs during the summer vacation. The sidewalk was not roped off, as is sometimes done in congested districts.

FIGURE 19.—Large brick dormitory at Walter Reed Hospital, Washington, D. C. This building was fumigated with hydrocyanic acid gas from the attic rooms to the commissary in the basement. Note proximity of surrounding buildings, which were all occupied during the fumigation. The entire building was vacated for a 24-hour period

remain, provided the windows are kept open. The gas, being lighter than air, escapes upward quickly. If the day is muggy and humid, however, ventilation proceeds very slowly. As a rule, one can enter

a house safely when there is no strong odor of gas. A bitter taste is a danger sign.

If the house is occupied, all windows should be left open for several hours and some should be left partly open for at least 24 hours after ventilation. The bedding should be well aired. If the rooms are occupied the night after fumigation, the windows should be kept wide open throughout the night, since the gas may cling to mattresses and pillows for several hours and may be given off in a dangerous amount if thorough ventilation is not maintained.

GAS MASKS

Several types of gas masks suitable for fumigation work are on the market. The best has a face piece of leather, rubber, or rubberized fabric which can be adjusted to fit tightly across the forehead,

FIGURE 20.—Combination of stores and dwelling apartments. The corner store was fumigated successfully with hydrocyanic acid gas after all occupants of the building had signed an agreement to vacate their quarters for a 2-hour fumigation of the store. The fumigator had access to the building at the right, but no gas penetrated its walls.

along the sides of the face, and under the chin. This face piece is provided with large eyepieces and is connected by a short flexible tube to a metal canister containing absorbent materials. (See cover illustration.) These materials, either by absorption or by chemical reaction, remove certain gases and vapors from the air. An arrangement of valves in the gas mask requires all air breathed by the wearer to pass through the chemicals in the canister, which absorb the poisonous gas.

Canisters are of different types and protect against many different gases. A fumigator should be sure that the canister he is using protects him against hydrocyanic acid gas. If he is using a form of cyanide that contains chloropicrin as a warning gas, the ordinary

canister for hydrocyanic acid gas will not be adequate and one that will protect against both gases must be used.

A canister will last for only a certain period, which depends upon the concentration of the gases to which the canister is subjected, the length of the exposure, and the manner in which it is stored when not in use. As supplied by the manufacturer, the canister is sealed by a cap over the inlet valve and by a cork in the nipple. Stored in this condition and without use the canister should last a year. If air is allowed to enter, the contents of the canister deteriorate rapidly. A fresh canister is good for several hours of continuous use. When it begins to give out, the gas fumes will penetrate the mask. When this occurs the wearer should immediately go into fresh air and replace the canister with a new one. Canisters are cheap.

Before being used a mask should always be tested for leaks by closing the bottom opening of the canister with the hand and attempting to breathe with the mask on. If no air can be obtained the mask is fit for use.

TREATMENT OF PERSONS OVERCOME BY GAS

A person overcome by the gas should be removed at once from the poisonous atmosphere and placed in fresh, but not cold, air. Chilling should be avoided as it increases the liability to pneumonia. If breathing has stopped, artificial respiration should be started and continued until normal breathing is restored. The victim should be wrapped in warm blankets and all tight clothes loosened around the neck, chest, and waist. If possible, a mixture of oxygen and 5 per cent carbon dioxide should be administered for 20 to 30 minutes, with the aid of a specially designed inhalator.

Other forms of medication are said to be of little use in the immediate treatment of poisoning by noxious gases.

Alcohol should not be administered and emetics are useless. Water should not be thrown on the patient in an effort to revive him, for this will do more harm than good. Under no circumstances should a gassed person be allowed to exercise; he should be made to lie down and remain as quiet as possible.

DO NOT FUMIGATE WHEN ALONE, OR WHEN CLOTHING IS WET WITH PERSPIRATION

No one should conduct a fumigation alone. He should be accompanied by one or more persons, and one of the party should be kept in reserve in order to assist in case a fumigator feels the need of fresh air. If a person feels the slightest faintness or weakness while fumigating he should call to his companion to assist him outside, where he should lie down and rest until he feels normal once more. Dizziness, weakness in the knees, and nausea are all indications that one should seek the open air. In properly conducting a fumigation none of these symptoms should develop.

Large buildings that have been closed for fumigation are usually hot and the fumigators are apt to perspire freely. It is well not to start a fumigation while wearing clothing wet with perspiration and care should be taken never to expose oneself unnecessarily to the fumigant.

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